CLAIMS

What is claimed is:

1. A method of reversibly producing a source of hydrogen gas comprising:

mixing together at least two hydrogen-containing starting materials;

heating said mixed materials at a temperature sufficient to release hydrogen and to form a residue which comprises at least one material which is different from said starting materials; and

regenerating at least one of said hydrogen-containing starting materials by exposing said residue to hydrogen gas.

2. The method of Claim 1 wherein said starting materials comprise amide and hydride.

3. The method of Claim 2 wherein said residue comprises imide and said regenerating forms said amide.

4. The method of Claim 1 wherein said starting materials comprise an amide, $MI^{d}(NH_2)_{d}^{+1}$ and a hydride, $MII^{f}H_{f}$; said residue comprises an imide, $M^{c}(NH)_{\frac{c}{2}}^{+2}$; and said regenerating forms said amide and hydride.

5. The method of Claim 4 where M, MI and MII are each independently selected from the group consisting of CH_3, Al, As, B, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, W, Y, Yb, Zn, Zr, and mixtures thereof.

6. The method of Claim 4 where M, MI and MII are each independently selected from the group consisting of Ba, Be, Ca, Cs, Eu, In, K, La, Li, Mg, Na, Ni, Rb, Sm, Sr, Yb, and mixtures thereof.

7. The method of Claim 1 wherein said starting materials comprise an amide and an alanate.

8. The method of Claim 7 wherein said residue comprises an imide, and said regenerating forms said amide.

9. The method of Claim 8 wherein said amide is represented by $MI^{d}(NH_2)_{d}^{+1}$; said imide is represented by $M^{c}(NH)_{\frac{c}{2}}^{+2}$ and said alanate is represented by $M'M''H_4$; where M'' represents a +3 charge species, and where M, MI and M' each represent a cationic species different from hydrogen.

10. The method of Claim 9 wherein said cationic species is selected from the group consisting of CH_3, Al, As, B, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, W, Y, Yb, Zn, Zr, and mixtures thereof.

11. The method of Claim 9 wherein said cationic species is selected from the group consisting of Ba, Be, Ca, Cs, Eu, In, K, La, Li, Mg, Na, Ni, Rb, Sm, Sr, Yb, and mixtures thereof.

12. The method of Claim 9 wherein said M'' is selected from the group consisting of aluminum, boron, and mixtures thereof.

13. The method of Claim 9 wherein said M″ is a mixture of elements having an average +3 charge.

14. The method of Claim 13 wherein said mixture of elements is a mixture of Ti^{+4} and Zn^{+2}

15. The method of Claim 7 wherein the heating is conducted in two stages; a first stage where said alanate is decomposed in the presence of said amide to release hydrogen, and to produce a hydride and aluminum; and second stage, where said amide and said hydride react in the presence of said aluminum to further release hydrogen.

16. The method of Claim 15 wherein said first and second stages are conducted according to:

$$LiNH_2 + LiAlH_4 \rightarrow LiNH_2 + LiH + Al + \frac{3}{2} H_2 \rightarrow Li_2NH + Al + \frac{5}{2} H_2$$

17. The method of Claim 15 wherein said first and second stages are conducted according to:

$$4\ LiNH_2 + LiAlH_4 \rightarrow 4\ LiNH_2 + LiH + Al + 3/2\ H_2 \rightarrow [Li_5Al][NH]_4 + 4\ H_2$$

18. The method of Claim 15 wherein said first and second stages are conducted according to:

$$LiNH_2 + NaAlH_4 \rightarrow LiNH_2 + NaH + Al + 2H_2 \rightarrow (LiNa)NH + Al + \frac{5}{2}H_2$$

19. The method of Claim 9 wherein said $M'M''H_4$ is selected from the group consisting of $LiAlH_4$, $NaAlH_4$, $LiBH_4$, $NaBH_4$ and mixtures thereof.

20. A hydrogen storage medium having a hydrogenated state and a dehydrogenated state:

(a) in said hydrogenated state, said medium comprises an amide and a hydride; and

(b) in said dehydrogenated state, said medium comprises a residue which comprises at least one material which is different from said amide or hydride.

21. The hydrogen storage medium of Claim 20 wherein said hydride is an alanate represented by the formula $ZAlH_4$ where Z comprises at least one selected from the group consisting of alkali and alkaline earth metals.

22. The hydrogen storage medium of Claim 21 wherein Z is lithium and the alanate is $LiAlH_4$.

23. The hydrogen storage medium of Claim 20 wherein said hydride is a borohydride represented by ZBH_4 and Z comprises at least one selected from the group consisting of alkali and alkaline earth metals.

24. The hydrogen storage medium of Claim 20 wherein said amide is represented by the formula $LiNH_2$.

25. The hydrogen storage medium of Claim 20 wherein said hydride is represented by the formula LiH.

26. The hydrogen storage medium of Claim 20 wherein said residue comprises a hydride which is different from said hydrogenated state hydride.

27. The hydrogen storage medium of Claim 26 wherein said hydrogenated state hydride is an alanate and said different hydride of said residue is an alkali or alkaline earth hydride.

28. The hydrogen storage medium of Claim 26 wherein said hydrogenated state hydride is a borohydride and said different hydride is an alkali or alkaline earth hydride.

29. The hydrogen storage medium of Claim 20 wherein said hydrogenated state hydride is selected from the group consisting of $LiAlH_4$, $NaAlH_4$, $NaBH_4$, $LiBH_4$, $LiBH_4$ and mixtures thereof.

30. A method of producing a source of hydrogen gas comprising: liberating hydrogen from a hydrogenated composition comprising at least two different hydrogen-containing starting materials, by heating said hydrogenated composition at an elevated temperature sufficient to evolve hydrogen gas therefrom, thereby producing dehydrogenated product which comprises a material which is different from at least one of said starting materials.